

CLAIMS

What is claimed is:

1. A method for removing flash artifacts comprising the steps of:
 - a) capturing a first digital image of a subject;
 - b) capturing a second digital image of said subject with the use of a flash;
 - c) creating a difference image of said first and second digital images;
 - d) applying a threshold to said difference image to create an artifact image; and
 - e) subtracting said artifact image from said second digital image, resulting in a final digital image.
2. A method for removing flash artifacts as recited in claim 1;
wherein said artifact image is multiplied by a factor before the step of subtracting said artifact image from said second digital image.
3. A method for removing flash artifacts as recited in claim 1;
wherein said artifact image is offset by a factor before said step of subtracting said artifact image from said second digital image.
4. A method for removing flash artifacts as recited in claim 1;
wherein said difference image comprises intensity data.
5. A method for removing flash artifacts as recited in claim 1, further comprising the step of:
 - f) storing said final digital image in a memory device.
6. A method for removing flash artifacts as recited in claim 1;
wherein said threshold can be set by a user.
7. A method for removing flash artifacts as recited in claim 1;
wherein said threshold is calculated from a histogram of said difference image.
8. A method for removing flash artifacts comprising the steps of:

- 2 a) capturing a first digital image of a subject;
- b) capturing a second digital image of said subject with the use of a flash;
- 4 c) creating at least three difference images of said first and second digital images,
including a red difference image, a green difference image, and a blue difference
6 image;
- d) applying a red threshold, a green threshold, and a blue threshold to said red, green,
8 and blue difference images to create at least three artifact images, including a red
artifact image, a green artifact image, and a blue artifact image; and
- 10 e) subtracting said red, green, and blue artifact images from said second digital
image, resulting in a final digital image.

9. A method for removing flash artifacts as recited in claim 8;
2 wherein said red, green, and blue artifact images are multiplied by a factor before the
step of subtracting said red, green, and blue artifact images from said second
4 digital image.

10. A method for removing flash artifacts as recited in claim 8;
2 wherein said red, green, and blue artifact images are offset by a factor before the step
of subtracting said red, green, and blue artifact images from said second digital
4 image.

11. A method for removing flash artifacts as recited in claim 8;
2 wherein said red, green, and blue thresholds are set independently and comprise
chromatic data.

12. A method for removing flash artifacts as recited in claim 8;
2 wherein said red, green, and blue thresholds are based on pixel intensity.

13. A method for removing flash artifacts as recited in claim 8;

2 wherein said pixel intensity is calculated according to the National Television System
Committee (NTSC) standard.

14. A method for removing flash artifacts as recited in claim 8, further comprising the
2 step of:

f) storing said final digital image in a memory device.

15. A method for removing flash artifacts as recited in claim 8;

2 wherein said red threshold, green threshold, and blue threshold can be set by a user.

16. A method for removing flash artifacts as recited in claim 8;

2 wherein said red threshold is calculated from a red histogram of said red difference

image; said green threshold is calculated from a green histogram of said green

4 difference image; and said blue threshold is calculated from a blue histogram of

said blue difference image.

17. A method for removing flash artifacts comprising the steps of:

2 a) capturing a first digital image of a subject;

b) capturing a second digital image of said subject with the use of a flash;

4 c) creating at least three difference images of said first and second digital images,
including a yellow difference image, a cyan difference image, and a magenta
6 difference image;

d) applying a yellow threshold, a cyan threshold, and a magenta threshold to said
8 yellow, cyan, and magenta difference images to create at least three artifact
images, including a yellow artifact image, a cyan artifact image, and a magenta
10 artifact image; and

e) subtracting said yellow, cyan, and magenta artifact images from said second
12 digital image, resulting in a final digital image.

18. A method for removing flash artifacts as recited in claim 17;

2 wherein said yellow, cyan, and magenta artifact images are multiplied by a factor
before the step of subtracting said yellow, cyan, and magenta artifact images from
4 said second digital image.

19. A method for removing flash artifacts as recited in claim 17;

2 wherein said yellow, cyan, and magenta artifact images are offset by a factor before
the step of subtracting said yellow, cyan, and magenta artifact images from said
4 second digital image.

20. A method for removing flash artifacts as recited in claim 17;

2 wherein said yellow, cyan, and magenta thresholds are set independently and
comprise chromatic data.

21. A method for removing flash artifacts as recited in claim 17;

2 wherein said yellow, cyan, and magenta thresholds are based on pixel intensity.

22. A method for removing flash artifacts as recited in claim 21;

2 wherein said pixel intensity is calculated according to the National Television System
Committee (NTSC) standard.

23. A method for removing flash artifacts as recited in claim 17, further comprising the
2 step of:

f) storing said final digital image in a memory device.

24. A method for removing flash artifacts as recited in claim 17;

2 wherein said yellow threshold, cyan threshold, and magenta threshold can be set by a
user.

25. A method for removing flash artifacts as recited in claim 17;

2 wherein said yellow threshold is calculated from a yellow histogram of said yellow
difference image; said cyan threshold is calculated from a cyan histogram of said

4 cyan difference image; and said magenta threshold is calculated from a magenta
histogram of said magenta difference image.

26. A device for removing flash artifacts comprising:

2 a first subtract block with inputs comprising flash-less digital image data and flash
digital image data, wherein said flash-less digital image data is subtracted from
4 said flash digital image data producing difference data;
a threshold block connected to said first subtract block, that determines a threshold
6 from said difference data;
a clipping block connected to said threshold block, that receives said difference data
8 and said threshold and outputs artifact data, wherein said artifact data contains
said difference data for said pixels with a value greater than said threshold; and
10 a second subtract block connected to said clipping block, wherein said second subtract
block subtracts said artifact data from said flash digital image data, resulting in a
12 final digital image.

27. A device for removing flash artifacts as recited in claim 26;

2 wherein said difference data comprises intensity data.

28. A device for removing flash artifacts as recited in claim 26;

2 wherein said threshold block calculates said threshold from a histogram.

29. A device for removing flash artifacts as recited in claim 26;

2 wherein said threshold block determines said threshold from a user input.

30. A device for removing flash artifacts comprising:

2 a first subtract block with inputs comprising flash-less digital image data and flash
digital image data, wherein said flash-less digital image data is subtracted from
4 said flash digital image data producing difference data;

a threshold block connected to said first subtract block, that determines a threshold
6 from said difference data;

a clipping block connected to said threshold block, that receives said difference data
8 and said threshold and outputs artifact data, wherein said artifact data contains
said difference data for said pixels with a value greater than said threshold;

10 a factor block connected to said clipping block that modifies said artifact data by a
factor and outputs factored artifact data; and

12 a second subtract block connected to said factor block, wherein said second subtract
block subtracts said factored artifact data from said flash digital image data,
14 resulting in a final digital image.

31. A device for removing flash artifacts as recited in claim 30;

2 wherein said factor block multiplies said artifact data by said factor.

32. A device for removing flash artifacts as recited in claim 30;

2 wherein said factor block adds said artifact data to said factor.

33. A device for removing flash artifacts as recited in claim 30;

2 wherein said difference data comprises intensity data.

34. A device for removing flash artifacts as recited in claim 30;

2 wherein said threshold block calculates said threshold from a histogram.

35. A device for removing flash artifacts as recited in claim 30;

2 wherein said threshold block determines said threshold from a user input.

36. A device for removing flash artifacts comprising:

2 a first subtract block with inputs comprising flash-less digital image data and flash
digital image data, wherein said flash-less digital image data is subtracted from
4 said flash digital image data producing difference data;

a threshold block connected to said first subtract block, that determines a threshold
6 from said difference data;

a clipping block connected to said threshold block, that receives said difference data
8 and said threshold and outputs artifact data, wherein said artifact data contains
said difference data for said pixels with a value greater than or equal to said
10 threshold; and

a second subtract block connected to said clipping block, wherein said second subtract
12 block subtracts said artifact data from said flash digital image data, resulting in a
final digital image.

37. A device for removing flash artifacts as recited in claim 36;

2 wherein said difference data comprises intensity data.

38. A device for removing flash artifacts as recited in claim 36;

2 wherein said threshold block calculates said threshold from a histogram.

39. A device for removing flash artifacts as recited in claim 36;

2 wherein said threshold block determines said threshold from a user input.

40. A device for removing flash artifacts comprising:

2 a first subtract block with inputs comprising flash-less digital image data and flash
digital image data, wherein said flash-less digital image data is subtracted from
4 said flash digital image data producing difference data;

a threshold block connected to said first subtract block, that determines a threshold
6 from said difference data;

a clipping block connected to said threshold block, that receives said difference data
8 and said threshold and outputs artifact data, wherein said artifact data contains
said difference data for said pixels with a value greater than or equal to said
10 threshold;

a factor block connected to said clipping block that modifies said artifact data by a

12 factor and outputs factored artifact data; and

a second subtract block connected to said factor block, wherein said second subtract

14 block subtracts said factored artifact data from said flash digital image data,
resulting in a final digital image.

41. A device for removing flash artifacts as recited in claim 40;

2 wherein said factor block multiplies said artifact data by said factor.

42. A device for removing flash artifacts as recited in claim 40;

2 wherein said factor block adds said artifact data to said factor.

43. A device for removing flash artifacts as recited in claim 40;

2 wherein said difference data comprises intensity data.

44. A device for removing flash artifacts as recited in claim 40;

2 wherein said threshold block calculates said threshold from a histogram.

45. A device for removing flash artifacts as recited in claim 40;

2 wherein said threshold block determines said threshold from a user input.

46. A device for removing flash artifacts comprising:

2 at least three first primary color subtraction blocks that subtract at least three primary
color flash-less digital image data from at least three primary color flash digital
4 image data producing at least three primary color difference data, wherein a first
primary color subtraction block subtracts a first primary color flash-less digital
6 image data from a first primary color flash digital image data producing a first
primary color difference data, and a second primary color subtraction block
8 subtracts a second primary color flash-less digital image data from a second
primary color flash digital image data producing a second primary color
10 difference data, and a third primary color subtraction block subtracts a third

primary color flash-less digital image data from a third primary color flash digital
image data producing a third primary color difference data;

at least three primary color threshold blocks connected to said at least three primary
color subtraction blocks, that determine at least three primary color thresholds
from said at least three primary color difference data, wherein a first primary color
threshold block connected to said first primary color subtraction block determines
a first primary color threshold from said first primary color difference data, and a
second primary color threshold block connected to said second primary color
subtraction block determines a second primary color threshold from said second
primary color difference data, and a third primary color threshold block connected
to said third primary color subtraction block determines a third primary color
threshold from said third primary color difference data;

at least three clipping blocks connected to said at least three threshold blocks, that
receive said difference data and said threshold and output at least three primary
color artifact data, wherein said primary color artifact data contains said difference
data for said pixels with a primary color value greater than said primary color
thresholds, also wherein a first clipping block is connected to said first threshold
block and receives said first difference data and said first threshold and outputs a
first primary color artifact data, and a second clipping block is connected to said
second threshold block and receives said second difference data and said second
threshold and outputs a second primary color artifact data, and a third clipping
block is connected to said third threshold block and receives said third difference
data and said third threshold and outputs a third primary color artifact data;

a merge block connected to said clipping blocks, that merges said at least three
primary color artifact data into full-color artifact data; and

36 a second subtract block connected to said merge block, that subtracts said artifact data
from said flash digital image data, resulting in a final digital image.

47. A device for removing flash artifacts as recited in claim 46;

2 wherein said primary colors are red, green, and blue.

48. A device for removing flash artifacts as recited in claim 46;

2 wherein said primary colors are yellow, cyan, and magenta.

49. A device for removing flash artifacts comprising:

2 at least three first primary color subtraction blocks that subtract at least three primary

color flash-less digital image data from at least three primary color flash digital

4 image data producing at least three primary color difference data, wherein a first

primary color subtraction block subtracts a first primary color flash-less digital

6 image data from a first primary color flash digital image data producing a first

primary color difference data, and a second primary color subtraction block

8 subtracts a second primary color flash-less digital image data from a second

primary color flash digital image data producing a second primary color

10 difference data, and a third primary color subtraction block subtracts a third

primary color flash-less digital image data from a third primary color flash digital

12 image data producing a third primary color difference data;

at least three primary color threshold blocks connected to said at least three primary

14 color subtraction blocks, that determine at least three primary color thresholds

from said at least three primary color difference data, wherein a first primary color

16 threshold block connected to said first primary color subtraction block determines

a first primary color threshold from said first primary color difference data, and a

18 second primary color threshold block connected to said second primary color

subtraction block determines a second primary color threshold from said second

20 primary color difference data, and a third primary color threshold block connected
to said third primary color subtraction block determines a third primary color
22 threshold from said third primary color difference data;
at least three clipping blocks connected to said at least three threshold blocks, that
24 receive said difference data and said threshold and output at least three primary
color artifact data, wherein said primary color artifact data contains said difference
26 data for said pixels with a primary color value greater than said primary color
thresholds, also wherein a first clipping block is connected to said first threshold
28 block and receives said first difference data and said first threshold and outputs a
first primary color artifact data, and a second clipping block is connected to said
30 second threshold block and receives said second difference data and said second
threshold and outputs a second primary color artifact data, and a third clipping
32 block is connected to said third threshold block and receives said third difference
data and said third threshold and outputs a third primary color artifact data;
34 at least three second subtract blocks connected to said clipping block, that subtract
said artifact data from said flash digital image data producing at least three
36 primary color final image data; and
a merge block connected to said second subtract blocks, that merges said at least three
38 primary color final image data into full-color final digital image data.

50. A device for removing flash artifacts as recited in claim 49;

2 wherein said primary colors are red, green, and blue.

51. A device for removing flash artifacts as recited in claim 49;

2 wherein said primary colors are yellow, cyan, and magenta.

52. A computer program storage medium readable by a computer, tangibly embodying a computer program of instructions executable by the computer to perform method steps for removing flash artifacts from digital image data, the steps comprising:

- a) capturing a first digital image of a subject;
- b) capturing a second digital image of said subject with the use of a flash;
- c) creating a difference image of said first and second digital images;
- d) applying a threshold to said difference image to create an artifact image; and
- e) subtracting said artifact image from said second digital image, resulting in a final digital image.

53. A computer program storage medium as recited in claim 52;

wherein said difference image comprises intensity data.

54. A computer program storage medium as recited in claim 52, the steps further comprising:

- f) storing said final digital image in a memory device.

55. A computer program storage medium as recited in claim 52;

wherein said threshold can be set by a user.

56. A computer program storage medium as recited in claim 52;

wherein said threshold is calculated from a histogram of said difference image.

57. A computer program storage medium readable by a computer, tangibly embodying a computer program of instructions executable by the computer to perform method steps for removing flash artifacts from digital image data, the steps comprising:

- a) capturing a first digital image of a subject;
- b) capturing a second digital image of said subject with the use of a flash;

- 6 c) creating at least three difference images of said first and second digital images,
including a red difference image, a green difference image, and a blue difference
8 image;
- d) applying a red threshold, a green threshold, and a blue threshold to said red, green
10 and blue difference images to create at least three artifact images, including a red
artifact image, a green artifact image, and a blue artifact image; and
- 12 e) subtracting said artifact image from said second digital image, resulting in a final
digital image.

58. A computer program storage medium as recited in claim 57, wherein said difference
2 image comprises intensity data.

59. A computer program storage medium as recited in claim 57, further comprising the
2 step of:

- f) storing said final digital image in a memory device.

60. A computer program storage medium as recited in claim 57, wherein said red
2 threshold, green threshold, and blue threshold can be set by a user.

61. A computer program storage medium as recited in claim 57, wherein said red
2 threshold is calculated from a red histogram of said red difference image; said green
threshold is calculated from a green histogram of said green difference image; and
4 said blue threshold is calculated from a blue histogram of said blue difference image.

62. A computer program storage medium readable by a computer, tangibly embodying a
2 computer program of instructions executable by the computer to perform method
steps for removing flash artifacts from digital image data, the steps comprising:

- 4 a) capturing a first digital image of a subject;
- b) capturing a second digital image of said subject with the use of a flash;

- 6 c) creating at least three difference images of said first and second digital images,
including a yellow difference image, a cyan difference image, and a magenta
8 difference image;
- d) applying a yellow threshold, a cyan threshold, and a magenta threshold to said
10 yellow difference image, cyan difference image, and magenta difference image to
create at least three artifact images including a yellow artifact image, a cyan
12 artifact image, and a magenta artifact image; and
- e) subtracting said artifact images from said second digital image, resulting in a final
14 digital image.

63. A computer program storage medium as recited in claim 62, further comprising the
2 step of:

- f) storing said final digital image in a memory device.

64. A computer program storage medium as recited in claim 62, wherein said yellow
2 threshold, cyan threshold, and magenta threshold can be set by a user.

65. A computer program storage medium as recited in claim 62, wherein said yellow
2 threshold is calculated from a yellow histogram of said yellow difference image; said
cyan threshold is calculated from a cyan histogram of said cyan difference image; and
4 said magenta threshold is calculated from a magenta histogram of said magenta
difference image.

66. A method for removing flash artifacts comprising the steps of:

- 2 a) capturing a first digital image of a subject;
- b) capturing a second digital image of said subject with the use of a flash;
- 4 c) selecting an intensity threshold; and
- d) for each pixel to be processed performing the sub-steps of:

6 i) subtracting intensity of current pixel in said first digital image from
intensity of current pixel in said second digital image resulting in a pixel
8 difference; and

10 ii) replacing current pixel in said second digital image with current pixel from
 said first digital image when said pixel difference is greater than said
 intensity threshold.

67. A method for removing flash artifacts as recited in claim 66, wherein said intensity threshold is set by a user.

68. A method for removing flash artifacts as recited in claim 66, further comprising the step of:

e) after all of said pixels to be processed have been processed, saving said second digital image in a memory device as a final digital image.

69. A method for removing flash artifacts comprising the steps of:

a) capturing a first digital image of a subject;

b) capturing a second digital image of said subject with the use of a flash;

c) selecting an intensity threshold; and

d) for each pixel to be processed performing the sub-steps of:

6 i) subtracting intensity of current pixel in said first digital image from
intensity of current pixel in said second digital image resulting in a pixel
8 difference; and

10 ii) replacing current pixel in said second digital image with current pixel from
 said first digital image when said pixel difference is greater than or equal
 to said intensity threshold.

70. A method for removing flash artifacts as recited in claim 69, wherein said threshold is set by a user.

71. A method for removing flash artifacts as recited in claim 69, further comprising the
step of:

e) after all of said pixels to be processed have been processed, saving said second
digital image in a memory device as a final digital image.

72. A method for removing flash artifacts comprising the steps of:

a) capturing a first digital image of a subject;

b) capturing a second digital image of said subject with the use of a flash;

c) selecting at least three primary color thresholds; and

d) for each primary color of each pixel to be processed performing the sub-steps of:

i) subtracting primary color value of current pixel in said first digital image from
primary color value of current pixel in said second digital image resulting in a
primary color pixel difference for the current primary color of the current
pixel; and

ii) replacing primary color value of current pixel in said second digital image
with primary color value of current pixel from said first digital image when
said primary color pixel difference for the current primary color of the current
pixel is greater than said primary color threshold for said current primary
color.

73. A method for removing flash artifacts as recited in claim 72;

wherein said primary colors include red, green, and blue.

74. A method for removing flash artifacts as recited in claim 72;

wherein said primary colors include yellow, cyan, and magenta.

75. A method for removing flash artifacts as recited in claim 72;

wherein said primary color thresholds are set by a user.

76. A method for removing flash artifacts as recited in claim 72, further comprising the
2 step of:

e) after all of said pixels to be processed have been processed, saving said second
4 digital image in a memory device as a final digital image.

77. A method for removing flash artifacts comprising the steps of:

2 a) capturing a first digital image of a subject;

b) capturing a second digital image of said subject with the use of a flash;

4 c) selecting at least three primary color thresholds; and

d) for each primary color of each pixel to be processed performing the sub-steps of:

6 i) subtracting primary color value of current pixel in said first digital image from
primary color value of current pixel in said second digital image resulting in a
8 primary color pixel difference for the current primary color of the current
pixel; and

10 ii) replacing primary color value of current pixel in said second digital image
with primary color value of current pixel from said first digital image when
12 said primary color pixel difference for the current primary color of the current
pixel is greater than or equal to said primary color threshold for said current
14 primary color.

78. A method for removing flash artifacts as recited in claim 77;

2 wherein said primary colors include red, green, and blue.

79. A method for removing flash artifacts as recited in claim 77;

2 wherein said primary colors include yellow, cyan, and magenta.

80. A method for removing flash artifacts as recited in claim 77;

2 wherein said primary color thresholds are set by a user.

81. A method for removing flash artifacts as recited in claim 77, further comprising the
step of:

- e) after all of said pixels to be processed have been processed, saving said second
digital image in a memory device as a final digital image.

82. A method for removing flash artifacts comprising the steps of:

- a) capturing a first digital image of a subject;
- b) capturing a second digital image of said subject with the use of a flash;
- c) selecting at least three primary color thresholds; and
- d) for each primary color of each pixel to be processed performing the sub-steps of:
 - i) subtracting primary color value of current pixel in said first digital image from
primary color value of current pixel in said second digital image resulting in a
primary color pixel difference for the current primary color of the current
pixel; and
 - ii) replacing primary color value of current pixel in said second digital image
with a color value calculated from said primary color value of current pixel in
said first digital image, and said primary color value of current pixel in said
second digital image, when said primary color pixel difference for the current
primary color of the current pixel is greater than said primary color threshold
for said current primary color.

83. A method for removing flash artifacts as recited in claim 82;

wherein said primary colors include red, green, and blue.

84. A method for removing flash artifacts as recited in claim 82;

wherein said primary colors include yellow, cyan, and magenta.

85. A method for removing flash artifacts as recited in claim 82;

wherein said primary color thresholds are set by a user.

86. A method for removing flash artifacts as recited in claim 82, further comprising the
2 step of:

j) after all of said pixels to be processed have been processed, saving said second
4 digital image in a memory device as a final digital image.

87. A method for removing flash artifacts comprising the steps of:

2 a) capturing a first digital image of a subject;

b) capturing a second digital image of said subject with the use of a flash;

4 c) selecting at least three primary color thresholds; and

d) for each primary color of each pixel to be processed performing the sub-steps of:

6 i) subtracting primary color value of current pixel in said first digital image from
primary color value of current pixel in said second digital image resulting in a
8 primary color pixel difference for the current primary color of the current
pixel; and

10 ii) replacing primary color value of current pixel in said second digital image
with a color value calculated from said primary color value of current pixel in
12 said first digital image, and said primary color value of current pixel in said
second digital image, when said primary color pixel difference for the current
14 primary color of the current pixel is greater than or equal to said primary color
threshold for said current primary color.

88. A method for removing flash artifacts as recited in claim 87;

2 wherein said primary colors include red, green, and blue.

89. A method for removing flash artifacts as recited in claim 87;

2 wherein said primary colors include yellow, cyan, and magenta.

90. A method for removing flash artifacts as recited in claim 87;

2 wherein said primary color thresholds are set by a user.

91. A method for removing flash artifacts as recited in claim 87, further comprising the
2 step of:

e) after all of said pixels to be processed have been processed, saving said second
4 digital image in a memory device as a final digital image.

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